of Aldebaran up to 1° to left of Jupiter, moving slowly westwards as before."

Mr. G. W. Lamplugh observed the display at Ramsay, Isle of Man, and to him the chief feature was "the predominance of a well-defined luminous bar extending across the heavens directly overhead from one horizon to the other—from magnetic east to west.

"The stars shone through this band of pale light with scarcely diminished brightness, but it was occasionally flecked by thin clouds. When I first saw it, at 9·20 p.m., there seemed to be traces of oblique striation crossing it, and Dr. Tellet, who called my attention to the display, states that ten minutes earlier, when the bar was at its brightest, these striations gave the effect of slightly twisted folds. Another informant remarked that the bar was formed shortly before 9 p.m. by the union overhead of rays which shot upwards for the east and west.

"The light waned rather rapidly with slight pulsations, and we thought that we could detect a slow southerly drift in the band before it vanished. The western portion died out before the eastern, which remained quite definite until 9·45 p.m. Meanwhile there had been a faintly diffused illumination of the northern heavens, with occasional suggestions of radiant streamers, but the whole quite subordinate in brightness to the band overhead.

"There was a westerly breeze and a nearly clear sky, with a low cloud-bank in the north-west, at the commencement of the display, but before 9·45 p.m. the wind had backed southward, and shortly afterwards the sky became suddenly overcast, though not before the aurora had faded to a scarcely perceptible glow. Half an hour later a slight shower fell."

The Rev. S. Barber says that the aurora was visible at Westnewton, Aspatria, in great brilliancy, as a band passing nearly over the zenith from the west to the east horizon at about 10 p.m. An arch of light was seen in the north from about 8.30, and some observers saw a shorter band almost north and south preceding the great band west and east.

Mr. J. Cuthbertson saw the display at Kilmarnock, N.B., as early as 7.45, "as a broad arch of light crossing the heavens from east to west. About 7.50 it was a very luminous pencil of light in the upper part of the heavens, through which stars of the second and third magnitude were distinctly visible, As it condensed it grew brighter. About ten minutes after I first observed it, it began to fade, and was invisible before 8 o'clock, leaving a temporary brightness in the western sky."

The aurora appears to have presented features very similar to those of the aurora of November 23, 1894, observations of which were discussed by Prof. A. S. Herschel in NATURE of January 10.

THE U.S. UNITS OF ELECTRICAL MEASURE.

By a law approved in the Senate of the United States, last July, it was enacted that the legal units of electrical measure in the United States should be as follows:—

(1) The unit of resistance shall be what is known as the international ohm, which is substantially equal to one thousand million units of resistance of the centimetre-gram-second system of electromagnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice fourteen and four thousand five hundred and twenty-one ten-thousandths grams in mass, of a constant cross-sectional area, and of the length of one hundred and six and three-tenths centimetres.

(2) The unit of current shall be what is known as the international ampere, which is one-tenth of the unit of current of the centimetre-gram-second system of electromagnetic units, and is the practical equivalent of the unvarying current, which, when passed through a solution of nitrate of silver in water in accordance with standard specifications, deposits silver at the rate of one thousand one hundred and eighteen millionths of a gram per second.

(3) The unit of electromotive force shall be what is known as the international volt, which is the electromotive force that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of an international ampere, and is practically equivalent to one thousand fourteen hundred and thirty-fourths of the electromotive force between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of fifteen degrees Centigrade, and prepared in the manner described in the standard specifications.

(4) The unit of quantity shall be what is known as the international coulomb, which is the quantity of electricity transferred by a current of one international ampere in one second.

(5) The unit of capacity shall be what is known as the international farad, which is the capacity of a condenser charged to a potential of one international volt by one international coulomb of electricity.

(6) The unit of work shall be the Joule, which is equal to ten million units of work in the centimetre-gram-second system, and which is practically equivalent to the energy expended in one second by an international ampere in an international ohm.

(7) The unit of power shall be the watt, which is equal to ten million units of power in the centimetre-gram-second system, and which is practically equivalent to the work done at the rate of one Joule per second.

(8) The unit of induction shall be the Henry, which is the induction in a circuit when the electromotive force induced in this circuit is one international volt while the inducing current varies at the rate of one ampere per second.

The National Academy of Sciences was instructed to prescribe and publish the specifications necessary for the practical application of the definitions of the ampere and volt given in the foregoing, and, to meet this requirement of Congress, a special committee was appointed to consider the subject. The committee, selected from members of the Academy, was as follows:—Prof. H. A. Rowland, chairman, General H. L. Abbot, Prof. G. F. Barker, Prof. C. S. Hastings, Prof. A. A. Michelson, Prof. J. Trowbridge, Dr. Carl Barus.

The report of this committee was submitted to the Academy at a special meeting held last month, and was then accepted and unanimously adopted. We extract the following details from the report, a copy of which has just reached us.

The Ampere.

In employing the silver voltameter to measure currents of about one ampere, the following arrangements shall be adopted:—

The kathode on which the silver is to be deposited shall take the form of a platinum bowl not less than 10 centimetres in diameter, and from 4 to 5 centimetres in depth.

The anode shall be a disc or plate of pure silver some 30 square centimetres in area and 2 or 3 millimetres in thickness.

This shall be supported horizontally in the liquid near the top of the solution by a silver rod riveted through its centre. To prevent the disintegrated silver which is formed on the anode from falling upon the kathode, the anode shall be wrapped around with pure filter paper, secured at the back by suitable folding.

The liquid shall consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

Method of making a Measurement.—The platinum bowl is to be washed consecutively with nitric acid, distilled water, and absolute alcohol; it is then to be dried at 160° C., and left to cool in a desiccator. When thoroughly cool it is to be weighed carefully.

It is to be nearly filled with the solution and connected to the rest of the circuit by being placed on a clean insulated copper support to which a binding screw is attached.

The anode is then to be immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are then to be made.

Contact is to be made at the key, noting the time. The current is to be allowed to pass for not less than half an hour, and the time of breaking contact observed.

The solution is now to be removed from the bowl, and the deposit washed with distilled water, and left to soak for at least six hours. It is then to be rinsed successively with distilled water and absolute alcohol, and dried in a hot-air bath at a temperature of about 160° C. After cooling in a desiccator it is to be weighed again. The gain in mass gives the silver deposited.

To find the time average of the current in amperes, this mass, expressed in grams, must be divided by the number of seconds during which the current has passed, and by 0·001118.

In determining the constant of an instrument by this method.

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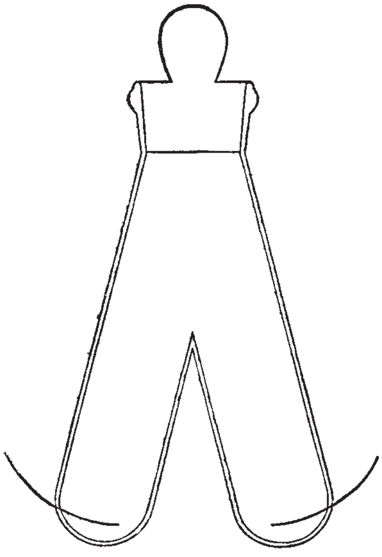
the current should be kept as nearly uniform as possible, and the readings of the instrument observed at frequent intervals of time. These observations give a curve from which the reading corresponding to the mean current (time-average of the current) can be found. The current, as calculated from the voltameter results, corresponds to this reading.

The current used in this experiment must be obtained from a battery, and not from a dynamo, especially when the instrument to be calibrated is an electrodynamometer.

The Volt.

Definition and Properties of the Cell.—The cell has for its positive electrode, mercury, and for its negative electrode, amalgamated zinc; the electrolyte consists of a saturated solution of zinc sulphate and mercurous sulphate. The electromotive force is 1·434 volts at 15° C., and between 10° C. and 25° C., by the increase of 1° C. in temperature, the electromotive force decreases by 0·00115 of a volt.

To set up the Cell.—The containing glass vessel, represented in the accompanying figure, shall consist of two limbs closed at bottom and joined above to a common neck fitted with a ground-glass stopper. The diameter of the limbs should be at least 2 centimetres, and their length at least 3 centimetres. The neck should be not less than 1·5 centimetres in diameter. At the bottom of each limb a platinum wire of about 0·4 millimetre diameter is sealed through the glass.



To set up the cell, place in one limb pure mercury, and in the other hot liquid amalgam, containing 90 parts mercury and 10 parts zinc. The platinum wires at the bottom must be completely covered by the mercury and the amalgam respectively. On the mercury, place a layer one centimetre thick of the zinc and mercurous sulphate paste described in 5. Both this paste and the zinc amalgam must then be covered with a layer of the neutral zinc sulphate crystals one centimetre thick. The whole vessel must then be filled with the saturated zinc sulphate solution, and the stopper inserted so that it shall just touch it, leaving, however, a small bubble to guard against breakage when the temperature rises.

Before finally inserting the glass stopper, it is to be brushed round its upper edge with a strong alcoholic solution of shellac, and pressed firmly in place.

ON THE NATURE OF MUSCULAR CONTRACTION.[1]

THE subject of this lecture is an inquiry into "The Nature of Muscular Contraction." Like all vital phenomena, muscular contraction is a most complicated process, composed of mechanical, chemical, thermal, and electrical changes in living matter. Hence it will be our task to become acquainted with these changes as completely and exactly as possible, and to ascertain their causal connection. Our inquiry must not be restricted to one special kind of muscle: it will have to extend to all the different forms, for there can be no doubt but that in all these cases the principle of activity is the same. Nay, it will be necessary to deal even with the other phenomena of so-called contractility, such as protoplasmic and ciliary motion, for all these different types of organic movement, however much they may differ from each other in details, are yet so connected by gradual transitions, that, to all appearance, one principle of motion, essentially the same, is applicable to all of them.

The general mechanical principle on which muscular contraction is based, will be discovered when we shall have ascertained in what way the power of shortening proceeds from the potential chemical energy which disappears upon stimulation of the muscle.

There can be no doubt as to the fact that the potential chemical energy of the component parts of muscular substance is alone the ultimate source of this power, for the existence of any other source cannot be proved. The quantity of energy which is imparted to the muscle by the stimulus is too small to be taken into consideration. The early opinion that the power required for contraction was imparted to the muscle through the medium of motor nerves has been refuted by experiments, such as, *e.g.*, on the persistence of contractility after degeneration of the motor nerves, and on the effects of direct artificial stimulation of the muscles; and it had even been refuted long ere the law of conservation of energy had thrown its light on the mutual connection between the phenomena of the living organs.

This law teaches that all the actual energy which appears in the muscle in consequence of stimulation must originate in an *equivalent* quantity of some other form of energy.

Now this form of energy is, in fact, given in the muscular substance liable to physiological combustion. The quantity of the latter is not only theoretically sufficient to produce that actual energy, but it has even been proved experimentally that during contraction that material gives birth to combinations such as carbonic acid, in the development of which potential chemical energy must have passed into other forms of energy. As far as the phenomena have been examined *quantitatively*, they confirm the conclusion that all muscular force must be derived from chemical energy.

Hence there is no difference about all these points. But with this result we have as yet gained only a basis for the proper solution. So soon you inquire in what way, by what transformations, does the mechanical force of contraction arise from chemical energy, difficulties and differences of opinion begin to present themselves.

A great many physiologists hold, with Pflüger, Fick, and Chauveau, that muscular force is a direct manifestation of chemical attraction; others, *e.g.*, Solvay, think that it is produced through the medium of electricity; others again, following J. R. Mayer, believe that the muscle is a thermodynamic machine, not unlike our caloric or steam engines.

The Chemiodynamic Hypothesis.—The first hypothesis, according to which contraction of muscle is a *direct* manifestation of chemical attraction—we may call it the chemiodynamic hypothesis—has to assume that the molecules, on the chemical combination of which this contraction is based, are regularly arranged within the contractile substance in such a way as to make them approach each other at their combination in the direction of the axis of the muscular fibres.

I think that this hypothesis of the identity of chemical attraction and muscular force meets with a fundamental difficulty in the fact that, in a single contraction, only a relatively infinitesimal part of the muscular substance is chemically active; 70 to 80 per cent. of the muscle (and even more) consists of absorbed water, the rest contains substances (albumin, salts, &c.) which, for the greater part, so far as can be proved, are not chemically concerned in the contraction.

This quantitative composition and this minute consumption of the active muscle compel us to assume that relatively only very few molecules of the muscular substance can be considered as sources of energy, and of these again it is generally but a small part that at a certain moment perform their function.

With certain presuppositions we may calculate the quantity of matter through the chemical action of which the amount of actual energy, produced at a certain contraction, must have been generated.

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[1] The Croonian Lecture, delivered by Prof. Th. W. Engelmann, at the Royal Society, on March 14.

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